

## Total phenol, antioxidant activity, fatty acid composition and mineral contents of the species of fungi known as domalan

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### Abstract

In this study, total phenol, antioxidant activity, fatty acid composition and mineral contents of the *Terfezia* species known as Domalan located in Konya region were determined. The majority of the truffles were gathered around Beşağıl Village Sarnıç Locality, Beşağıl Village Çiftlik Plateau Piren Tömeği Locality, Karapınar Çukurkuyu Plateau, Kale Village. Three species of truffles were identified during field works as *Terfezia clavery* Chatin, *Terfezia* sp. and *Picoa lefebvrei* (Pat.) Maire. *Terfezia clavery* and *Terfezia boudieri* are referred to as “Domalan”, *Picoa lefebvrei* is known as the Bird Domalan and *Terfezia* sp. is called White Domalan. Both crude fat (1.22%) and total phenol content (12.319 mg GAE/100ml) of *Terfezia clavery* were found to be higher than the other truffles. Oleic, linoleic and linolenic acid were identified as the major fatty acids in the samples. Very low levels of heavy metal content were detected in the samples. Lead (Pb) was not found in the samples of *Terfezia clavery* and *Terfezia* sp. The highest elements in the samples were potassium (K) and sulfur (S).

**Keywords:** *Terfezia*, *Ascomycetes*, Domalan, Mycorrhiza, Fatty acid, mineral

### 1. Introduction

*Terfezia* species, which were the subject of the study, were searched for in areas where *Helianthemum* communities are found. *Terfezia* (Tul. & C. Tul.) Tul. & C. Tul. 1851, the subject of this study, is located in the *Ascomycota* division of the class *Pezizomycetes* in the fungi kingdom. Truffles are hypogeous ascomycetes fungi that make a mycorrhizal association with some vascular plants. This study was undertaken to increase our knowledge on mineral contents that would be important for characterizing their nutritional value [1]. It is called as “Kumi, Keme, Dümbelek, Domalan, Tombalak” in Turkish [2]. Edible truffles are the fructification of some *Ascomycetes* fungi. Truffles are common in arid and semi arid regions of the world. These fungi have been considered edible since three thousand years [3]. Also, truffles are excellent nutritional sources with specific good taste [4,5]. In Turkey, *Terfezia* are known by their important economical income for local population and their good taste [2].

Fungi which are known as truffles are placed into the genus *Terfezia*, the most prominent representatives of which in our country and referred to as “keme” or “domalan” in the regions where they grow [6].

Species belonging to the genus composed of ascocarp are generally found in stepped and raw fields; they grow in Saudi Arabia, Kuwait, Iran, southern European Mediterranean countries and in other Mediterranean countries such as Spain, France, Italy, Cyprus, Syria, Algeria, Tunisia, Libya. In our country they grow in central and south-eastern Anatolia. They are sold as a seasonal vegetable in the spring at bazaars and markets. Truffles are attractive with a pleasant taste and smell and are high in economic value. Although they grow naturally in our country and are an important food source, truffles have not received much recognition.

In this study, authors said that among the people this fungi was used owing to its antimicrobial effects and in Tıbb-ı Nebevi, morphological and ecological characteristics of fungi in nature were examined. The aim of current study was to description to the total phenol, antioxidant activity, fatty acid composition and mineral contents of the *Terfezia* species known as Domalan located in Konya region.

## 2. Materials and methods

### 2.1. Material

Konya is in the middle-south part of Central Anatolia Region between 36° 22'-39° 08' north parallels and 31° 14'-34° 27' east meridians. The city was built up in an ancient lake field. Konya, a plateau, is the largest province (38 873 km<sup>2</sup>) in Turkey (Figure 1). Lakes are not included in this surface area. Average altitude is 1016 m. Continental climate conditions are preset in Konya. There are convection rains in the spring. Rainfall brings mobile air masses coming out of the Balkans in autumn. The samples were obtained from field studies in Beşağıl village and its highlands and Kale village's grassland areas. Fungus grown in the region of Konya and found in street markets were also used. Obtained fungi were brought to the laboratory in plastic bags. Some of these fungi were stored fresh in the deep freezer and others were preserved dry in the fungarium. In addition, during the field study, the local people's information about this fungi were gathered.



Figure 1. Study area

During field studies, the roots of the plants were collected and brought to the laboratory in bags then washed thoroughly with tap water until clear.

The samples were washed once distilled water, once with 0.2 N HCl solution, twice with distilled water and once with deionized water. Then, the excess water was removed by rough filter paper.

Obtained samples were identified from the study area as 3 species belonging to the genus *Terfezia*. These are; *Terfezia claveryi* (Fig.2), and *Terfezia* sp (Fig. 3). Also another fungi was identified as *Picoa lefebvrei* (Fig 4), which belongs to the same family. Samples were stored in Selçuk University Mushroom Application and Research Center.



Figure 2. Askokarp of *Terfezia claveryi*



Figure 3. *Terfezia* sp. Ascocarp



Figure 4. *Picoa lefebvrei* ascocarp

## 2.2. Identification of fungi

Macroscopic and microscopic characters of the collected fungi were investigated in the laboratory. Mushroom samples were identified using macroscopic characters (ascocarp type, shape, size, color, surface properties) and microscopic characters (periderm, gleba, ascus, ascospore features) along with other information obtained from field and laboratory investigations with the help of the relevant literature.

## 2.3. Chemical analysis of fungi samples

After fresh weight of the fungi were measured, the fungi were dried at 105°C in an oven until constant weight in order to determine the water content. Dried fungi were burned in an ash furnace at 900°C and the remaining part was considered the amount of ash. Ash that occurred by using the fresh weights of the samples was determined as percent amounts. For the amount of crude fat, fungi samples were sieved through a mill with 1 mm<sup>2</sup> sieve and crude fat was obtained according to the method of A.O.A.C. [7] with a soxhlet device. For fatty acid analysis, the composition of fatty acid methyl esters of the obtained crude fat was analyzed according to the methods of International Olive Oil Council.

### Determination of fatty acids

Fatty acid composition of terfezia oil were determined by the modified method using defined by Hışıl [8]. Oil samples were converted to fatty acid methyl esters by using BF-3 methanol. Fatty acid methyl esters (1 microliter) were analyzed by Varian 2100 branded gas chromatography with flame ion detector (FID). The standard mixture of fatty acids (Sigma Chemical Co.) was used for identification of peaks [7].

### Working conditions of GC

Name of GC: Varian 2100  
Constant phase: 10% DEGS (diethylene glycol succinate) + 1% H<sub>3</sub>PO<sub>4</sub>  
Support matter: Chromosorb G (100/120 mesh)  
Column: stainless steel (190 cm length x 0.2 µm i.d.)  
Detector: FID (Flame Ionization Detector)

Temperature :

Injection temperature: 225 °C  
Detector temperature: 225 °C  
Column temperature: 200 °C  
Total Flow Rate (ml/d): 30 ml/min

Flow rates:

Carrier gas (N<sub>2</sub>) : 6 ml /min.  
Burning gas (H<sub>2</sub>) : 40 ml/min.  
Dry air (O<sub>2</sub>) : 60 ml/min.  
Injection amount : 5 µl

The amount of total phenolic compounds was determined colorimetrically by using the Folin-Ciocalteu method [9]. Antioxidant activity in the phenolic content of the extracted samples was measured using DPPH (2,2-diphenyl-1-picrylhydrazil) by the free radical method and the results were given as % [10].

## 2.4. Mineral substances

Calcium carbonate (CaCO<sub>3</sub>) was determined as described by Hizalan and Ünal [11] with a Scheibler calcimeter.

The amount of extractable cations (Ca, Mg, K, Na) by using 1 N NH<sub>4</sub>OAc [12] were determined by ICP-OES (Inductively Coupled Plasma Optical Emission Spectrometer) (Varian-Vista) [13].

Total N (%) was measured by the micro-Kjeldahl method described by Jackson [14]. Available P was measured using 0.5 N NaHCO<sub>3</sub> according to the method of Olsen [12]. In obtained the extract containing 0.005M DTPA + 0.01M CaCl<sub>2</sub> + 0.1M TEA (pH = 7.3), available Fe, Zn, Cu, Mn, were determined using an ICP-OES (Varian-Vista) device [15]. The amount of total boron in fungi samples was determined according to the method of Hou et al. [16].

## 2.5. Statistical analyses

Results were analysed for statistical significance by analysis of variance [17]. This research was performed by three duplicates with a replicate.

**Table 1.** Crude fat, total amount of phenol and antioxidant substances

Samples	Crude oil (%)	Total Phenol (mg GAE/100 ml)	Antioxidant Activity (µg/ml)
<i>T. claveryi</i>	1.22	12.319	73.756
<i>Picoa lefebvrei</i>	0.80	9.899	75.264
<i>Terfezia</i> sp.	0.54	9.428	79.035

Table 2. Fatty acid compositions of terfezia oil (%).

Samples	Oleic acid	Linoleic acid	Linolenic acid	Erusic acid	Total fat acid
<i>T. clavery</i>	21.32	19.00	58.03	1.36	99.98
<i>Picoa lefebvrei</i>	16.86	12.97	60.63	9.51	99.97
<i>Terfezia</i> sp.	17.74	15.14	58.27	3.00	94.14

Table 3. Mineral contents of Terfezia (%).

Samples	Mo	Cd	Pb	B	Cr	Cu	Mn	Ni
<i>T. clavery</i>	0	0.1	0	0.1074	0.0048	0.0388	0.0115	0.0163
<i>Picoa lefebvrei</i>	0.0003	0.0001	0.0002	0.005	0.0018	0.003	0.0094	0.0067
<i>Terfezia</i> sp.	0.0006	0.0004	0	0.0015	0.0011	0.0018	0.0013	0.0048

  

Samples	Ca%	Fe%	K%	Mg%	Na%	P%	S%	Zn%
<i>T. clavery</i>	2.0518	0.2365	32.6784	1.5594	0.5363	8.9774	2.4884	0.0504
<i>Picoa lefebvrei</i>	0.2898	0.0115	3.4215	0.1382	0.2172	0.8472	1.4203	0.0055
<i>Terfezia</i> sp.	0.1133	0.0086	1.6871	0.1128	0.2639	0.691	1.0012	0.0041

### 3. Results and Discussion

In this study, chemical properties the types of *Terfezia* species known as truffles in Konya region were examined. Truffles known as “Domalan” collected from Beşağıl village Sarnıç locality, Beşağıl village Highland of Farm Piren Tömeği locality, Karapınar Çukurkuyu Plateau and the area around Kale village were analyzed. During field studies, 4 types of hypogeous fungi including *Terfezia clavery*, *Terfezia boudieri*, *Terfezia* sp. and *Picoa lefebvrei* were identified. *Terfezia clavery*, *Terfezia boudieri* are called as “Domalan”, *Picoa lefebvrei* is known as “Kuş Domalan”. White colored *Terfezia* sp. is named “White Domalan”.

Oil content of *Terfezia* spp changed between 1.22 and 0.54%. Total phenol contents ranged between 9.428 mgGAE/100 ml and 12.319 mgGAE/100ml and antioxidant activities were found between 73.756 µg/ml and 79.035 µg/ml (Table 2). *Terfezia clavery*'s crude fat and total phenol contents were found to be higher than the others. Gücin and Dülger [2] reported that *Terfezia boudieri* contained 6.40% oil (dw). The oil contents of some wild mushrooms were found between 1.40% and 10.58% [2]. In previous studies, oil contents of were found between 0.80% and 27.50% (dw) [18-21].

According to GC analysis, oleic, linoleic, and linolenic acids were identified as the major fatty acids of samples.

Oleic acid contents ranged from 16.86% to 21.32%, and linoleic acid contents varied between 58.03% and 60.63% (Table 2). Linolenic acid contents of samples varied between 12.97% and 19.00%. Content of erucic acid in *Picoa lefebvrei* (9.51%) was determined higher than the others. Yılmaz et al. [22] determined linoleic acid as basic fat acid in their study on species fatty acids composition of wild fungi (*Agaricus bisporus*, *Agaricus campestris*, *Boletus edulis*, *Coprinus comatus*, *Pleurotus ostreatus*, *Oudemansiella radicata* and *Armillaria mellea*) with contents varying between 13% and 59%.

Heavy metal contents were generally found to be very low (Table 3). Lead was found in *Terfezia claveryi* or *Terfezia* sp.. Copper (Cu) content ranged from 0.0018% to 0.0388% and nickel content ranged from 0.0048% to 0.0163%. Cu content in *Terfezia boudieri* was measured as 83mg/kg by Gücin and Dülger [2].

Potassium and sulphur were the most abundant elements. In general, the mineral contents of *Terfezia claveryi* were found higher than the others. Potassium contents ranged from 1.6871% (*Terfezia* sp.) to 32.6784% (*Terfezia claveryi*) while sulphur contents ranged from 1.0012% to 2.4884% (Table 3). Gücin and Dülger [2] reported a dry weight K content of 9960 mg/kg and Na content of 290 mg/kg in their study of *Terfezia boudieri*.



Çolak et al. [21]) measured Zn, Mn, Fe and Cu contents of 8 species of wild edible fungi (*Craterellus cornucopioides* (L.) P. Karst, *Armillaria mellea* (Vahl) P. Kumm., *Sarcodon imbricatus* (L.) P. Karst., *Lycoperdon perlatum* Pers., *Lactarius volemus* (Fr.) Fr., *Ramaria flava* (Schaeff.) Quéf., *Cantharellus cibarius* Fr., *Hydnum repandum* L.). Fe contents of fungi ranged from 30.20 mg/kg to 550.00 mg/kg while Cu contents ranged from 15.20mg/kg to 330.00mg/kg. Zn contents were reported to be between 47 mg/kg and 344 mg/kg. Elemental contents of *Terfezia boudieri* Chatin and *Terfezia clavaryi* Chatin growing in Konya (Karapınar and Çumra locations) province in Turkey were determined by inductively coupled plasma atomic emission spectrometry (ICP-AES). Potassium, phosphorus and magnesium contents of both truffles were found at high levels. While potassium content was found to be 12.9 and 11.9 g/Kg for *T. boudieri* and *T. clavaryi*, phosphorus contents of truffles ranged from 4.6 to 5.1 g/Kg, respectively [23]. Mn contents of some wild edible mushrooms changed between 7.10 and 143mg/kg [24].

When evaluating ethnomycology of the *Terfezia* species, in our country when these fungi are collected Southern East they are named keme grass, in Central Anatolia they are named Domalan; grass *Helianthemum* communities are commonly preferred collection places. The fungi are found 5-20 cm deep in the soil, where they cause bulges and fractures in the soil due to the growing fungi's increasing volume.

It has been seen that certain fungi, named truffles, are important for villagers as a source of income and food, but the villagers do have not sufficient information about the fungi. It is important that species of *Terfezia* are further researched so that the public can make more efficient use of this local treasure.

**Compliance with Ethics Requirements.** Authors declare that they respect the journal's ethics requirements. Authors declare that they have no conflict of interest and all procedures involving human / or animal subjects (if exist) respect the specific regulation and standards. **Disclosure statement:** No potential conflict of interest was reported by the authors.

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